



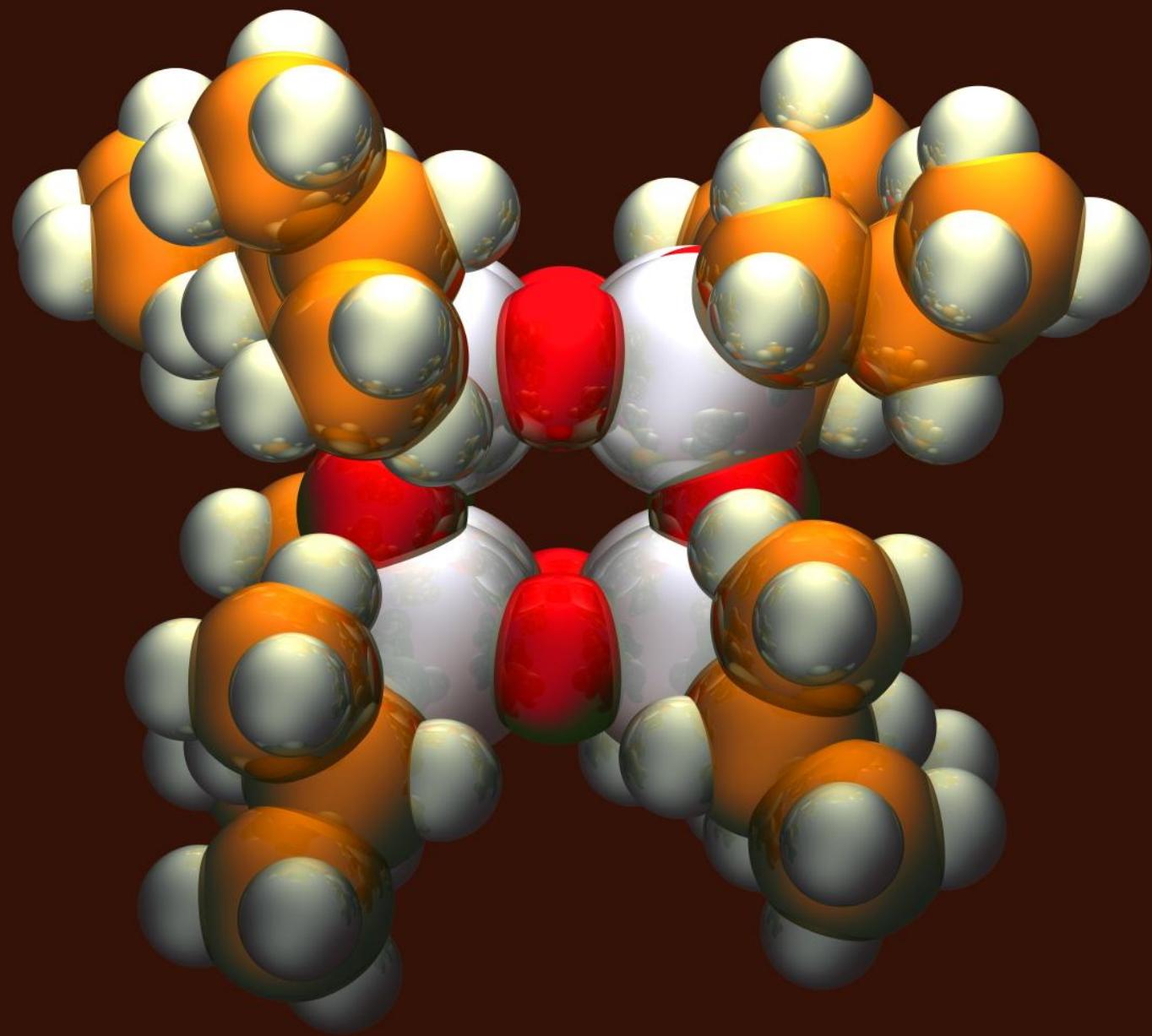
POSS® Enhancement of Plastics

**Dr. Chris DeArmitt FRSC
Chief Scientist**

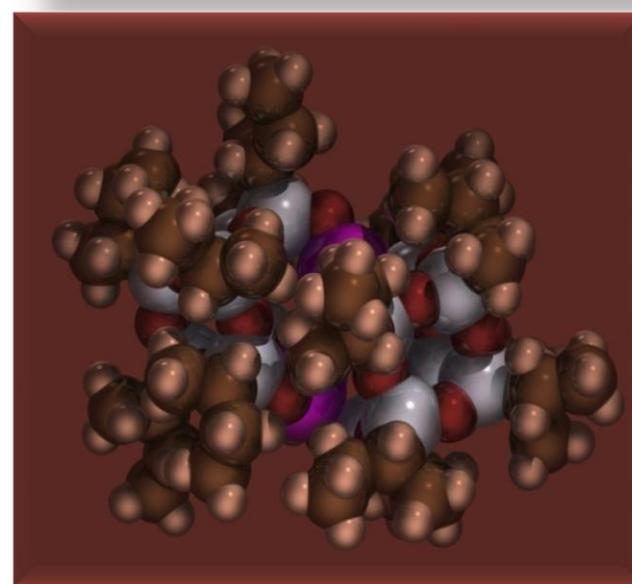
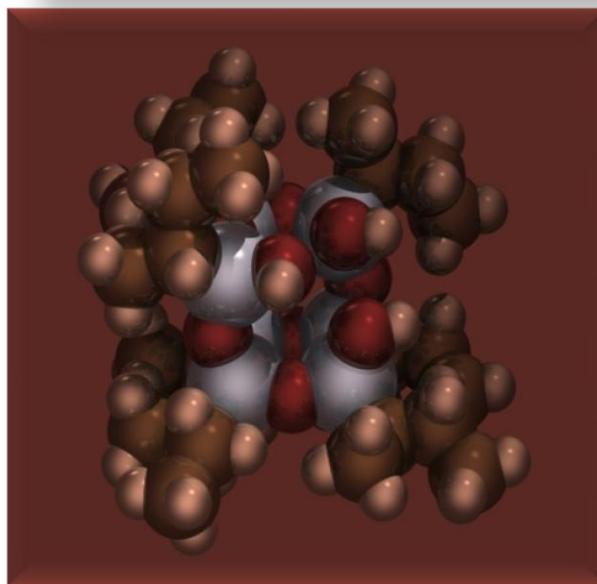
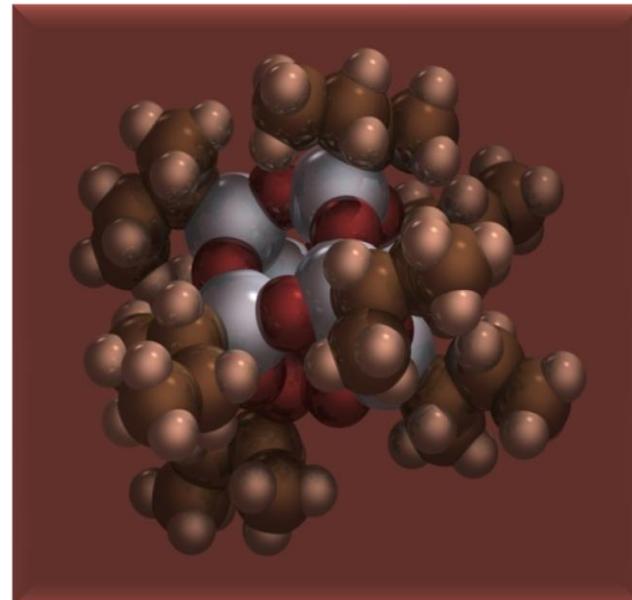
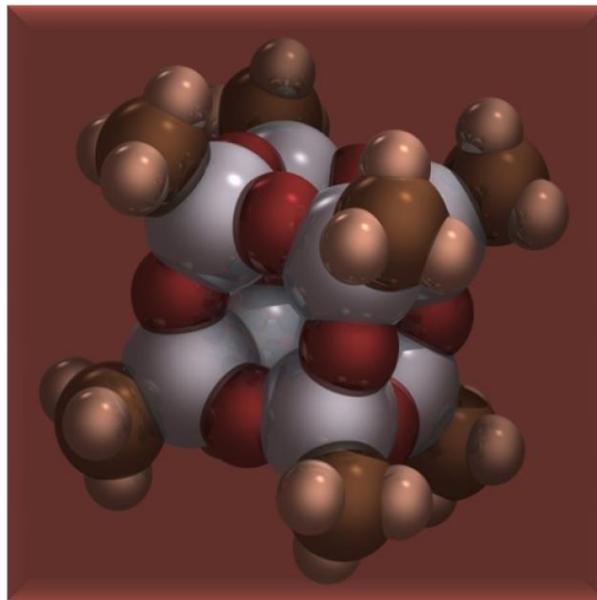
**Hybrid
Plastics™**

Overview

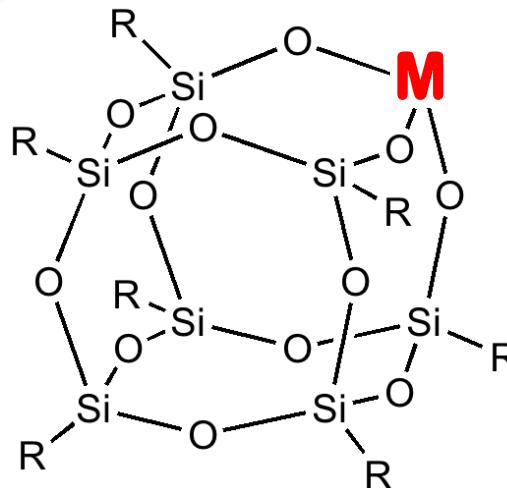
- What is POSS®?
- POSS® Flow enhancers
- Friction & hydrophobicity control
- Dispersants for pigments & fillers
- Copper passivation
- POSS® thermosets
- Safety and production of POSS®
- Conclusions



POSS® in 3D



Elements Incorporated into POSS®



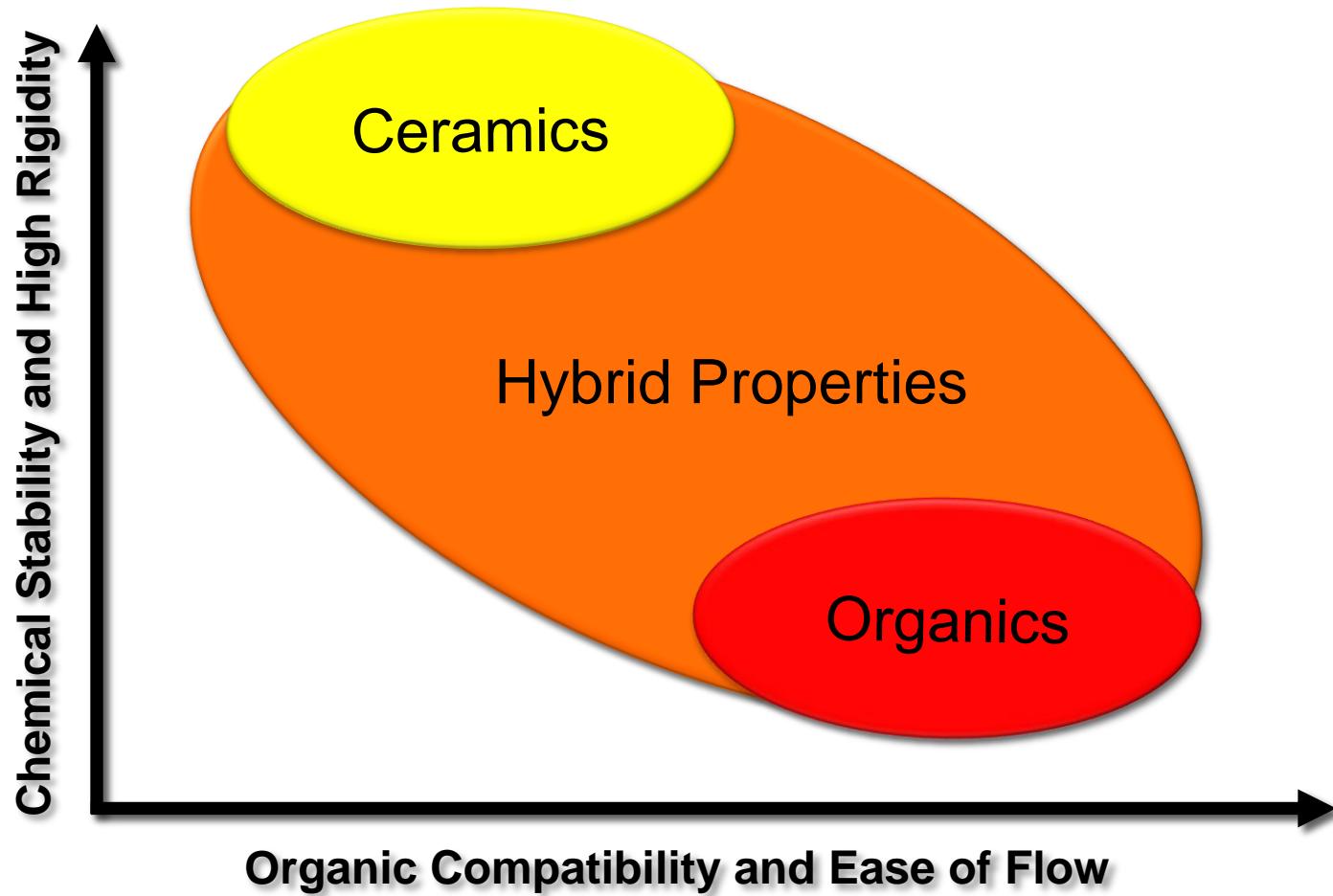
POMS reported

Not yet reported

Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

Why Hybrid Materials?

POSS® is a **unique** hybrid organic-inorganic composition



Hybrid Properties

Material Type	Density (gcm ⁻³)
Quartz	2.60
Amorphous silica	2.18
Octa hydrido POSS	1.82
Octa methyl POSS	1.50
Octa ethyl POSS	1.33
Octa i-butyl POSS	1.13
Octa i-octyl POSS	1.01
Iso-octane	0.69

What does POSS® look like?

Crystalline Solids

Wide melting range 24 C to 400 C

Liquids/Oils

Wide viscosity range 1000cP to 100000cP

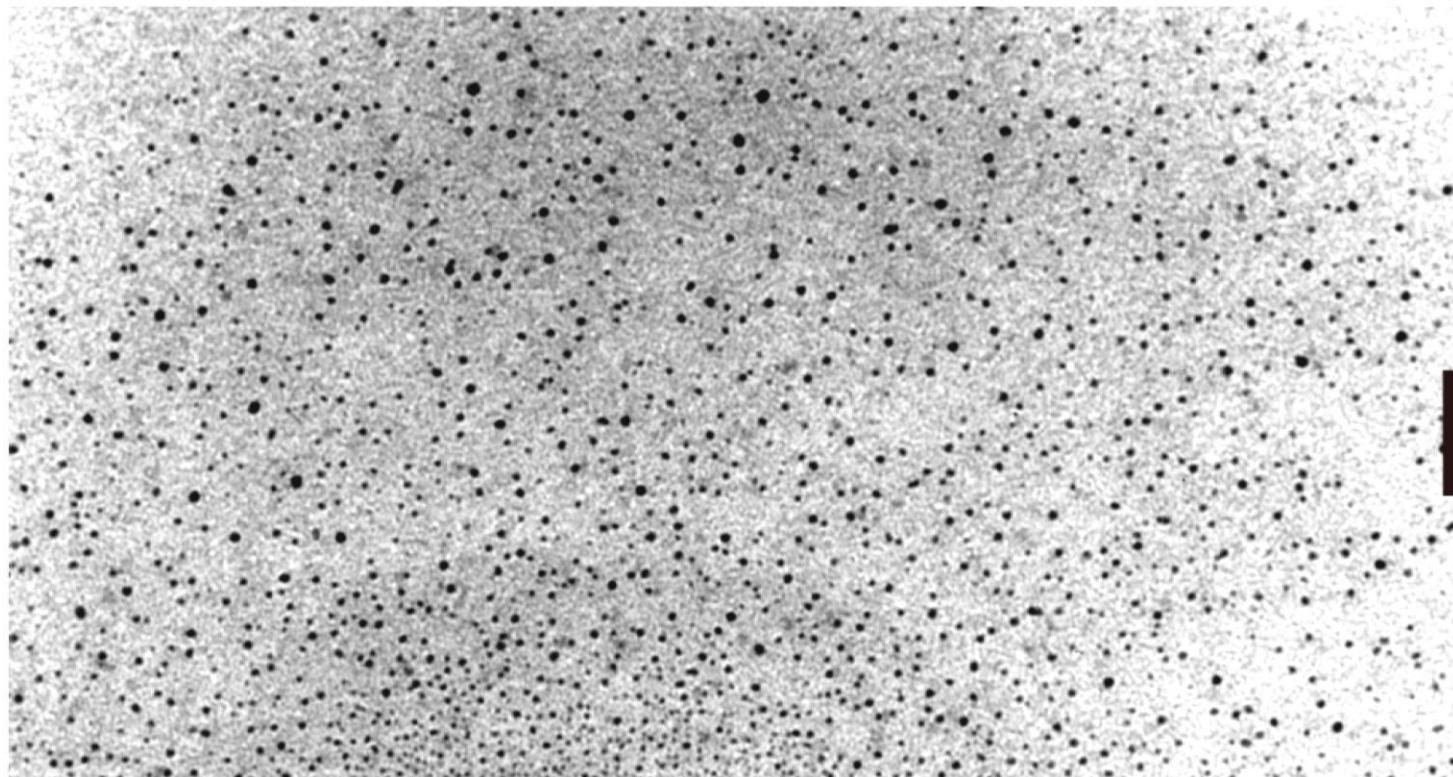


Waxes

**Hybrid
Plastics™**

POSS® Actually Dissolves in Polymer

Each “black dot” represents a 1.5nm POSS®



*scale of bar = 50nm

Viers - US Air Force Research Laboratory

**Hybrid
Plastics™**

What can POSS® do for you?

Increased T_g

Increased T_{decomp}

Extended temperature range

Reduced flammability

Radiation Resistance

Oxidation resistance

Reduce friction

Change permeability

Solvent resistance

Low volatility

Catalytic activity

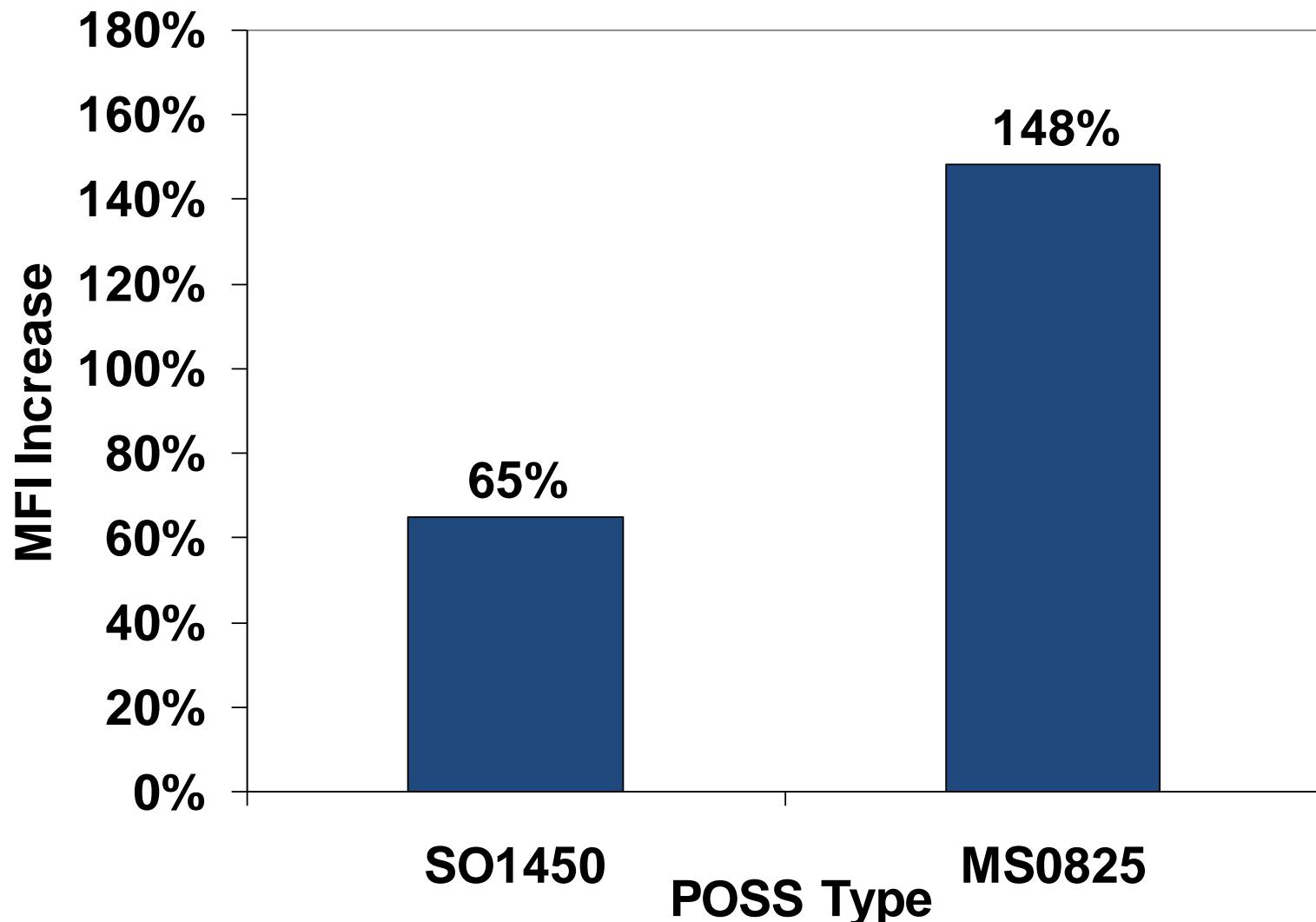
Improved Flow

Surface passivation

As a dispersant

Beat Competitor Patents

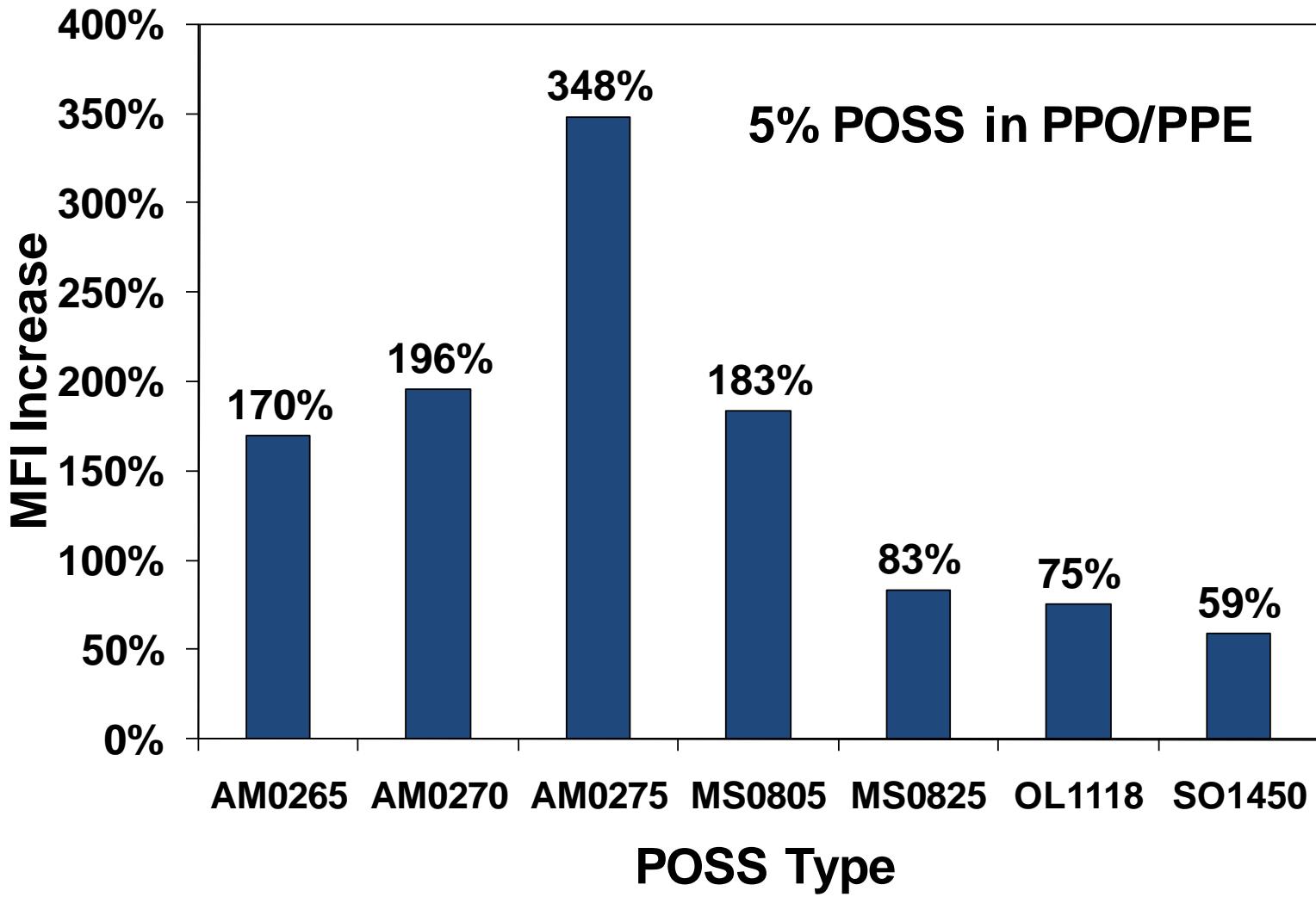
Flow Enhancement in COC (5% POSS®)



260 C 2.16kg

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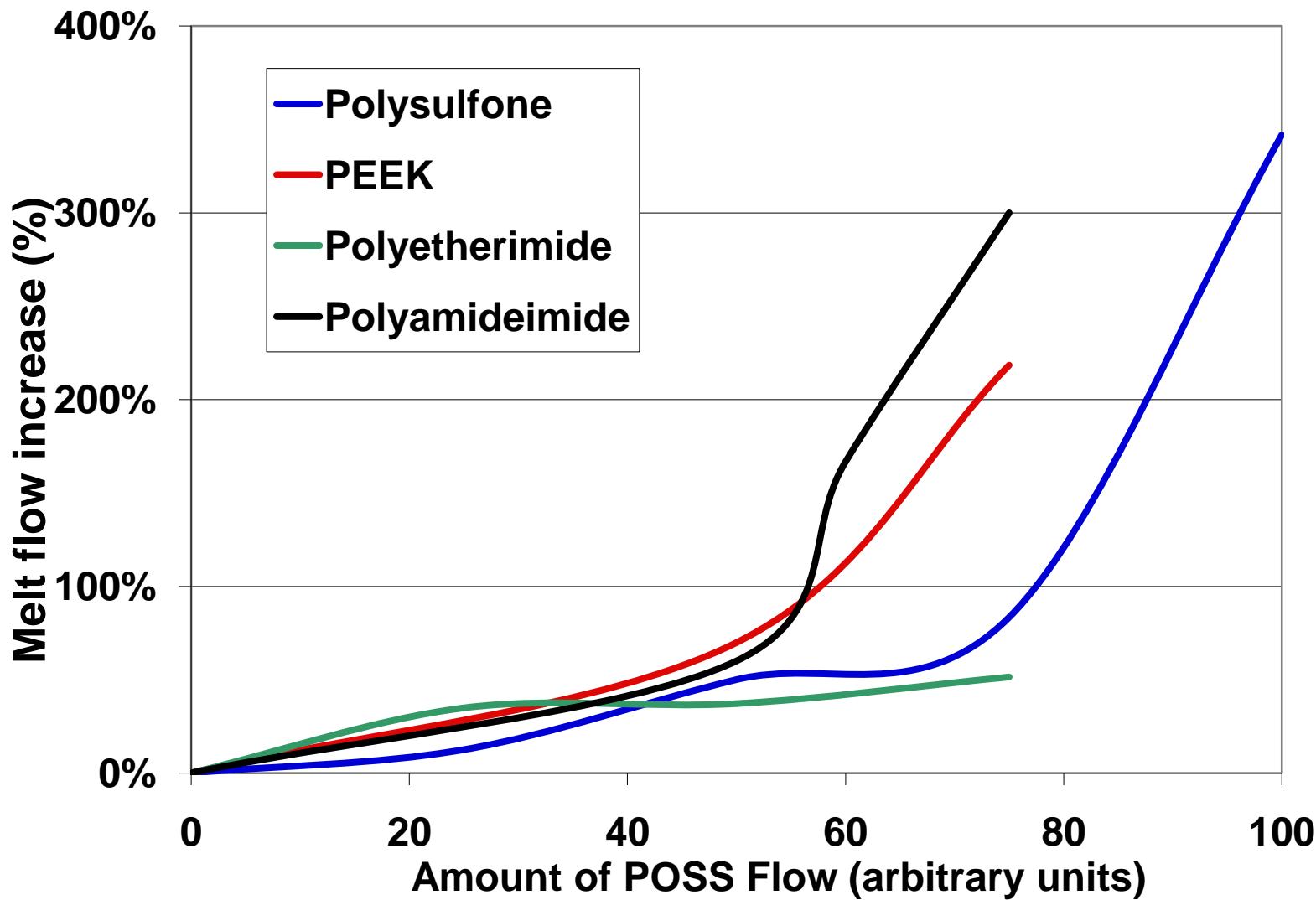
Flow Enhancement in PPO/PPE



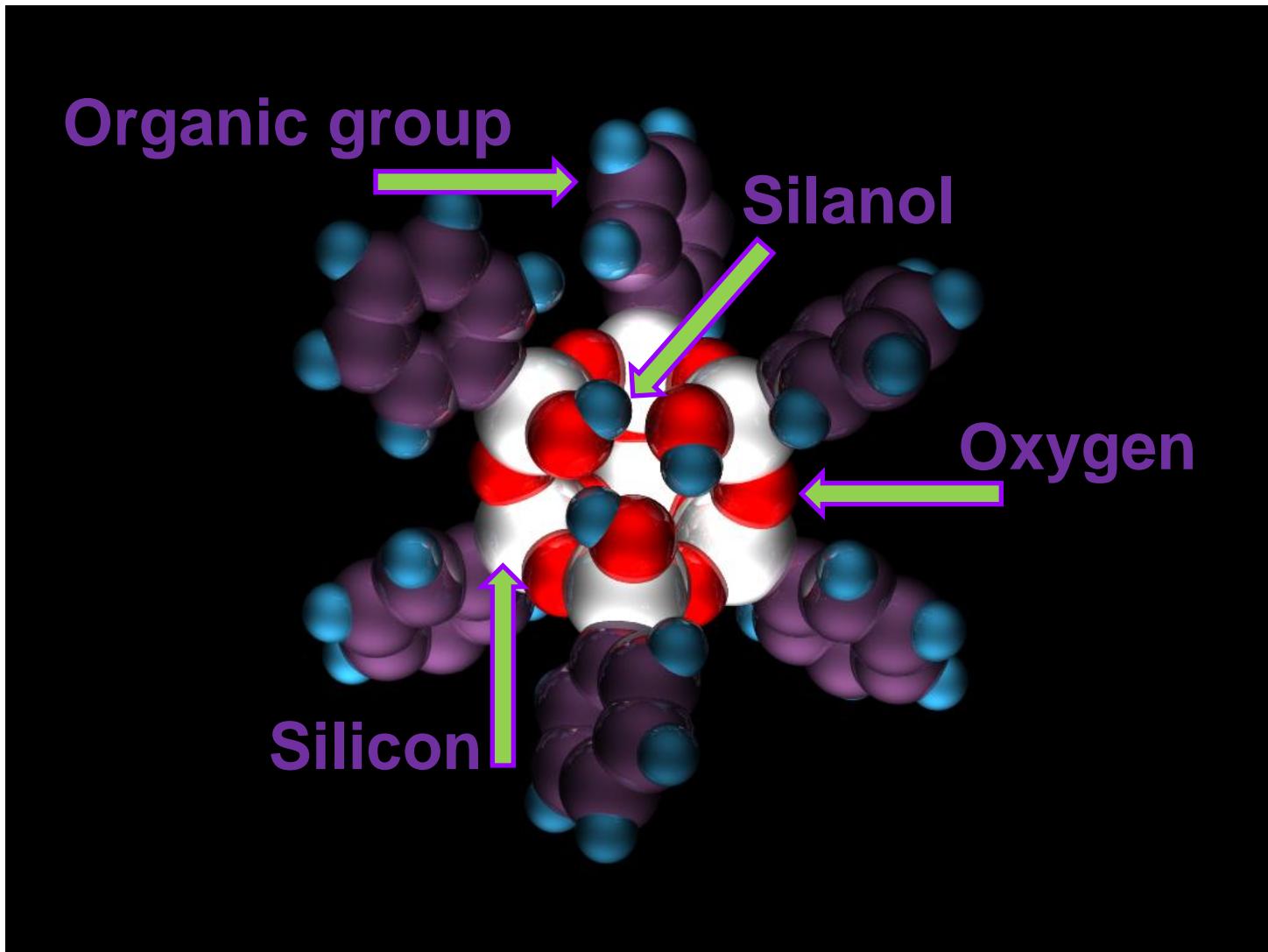
US 6, 759,460 & US 2004/0138355 Asahi Chemical

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POSS® Flow Masterbatches



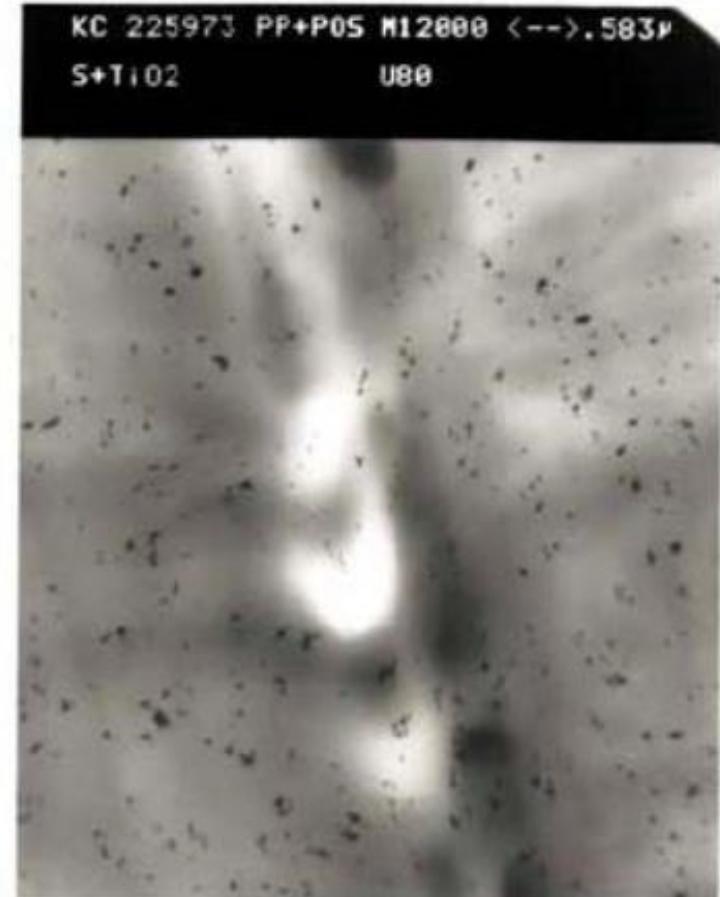
POSS® Trisilanols



TiO₂ Masterbatch with POSS® Dispersant



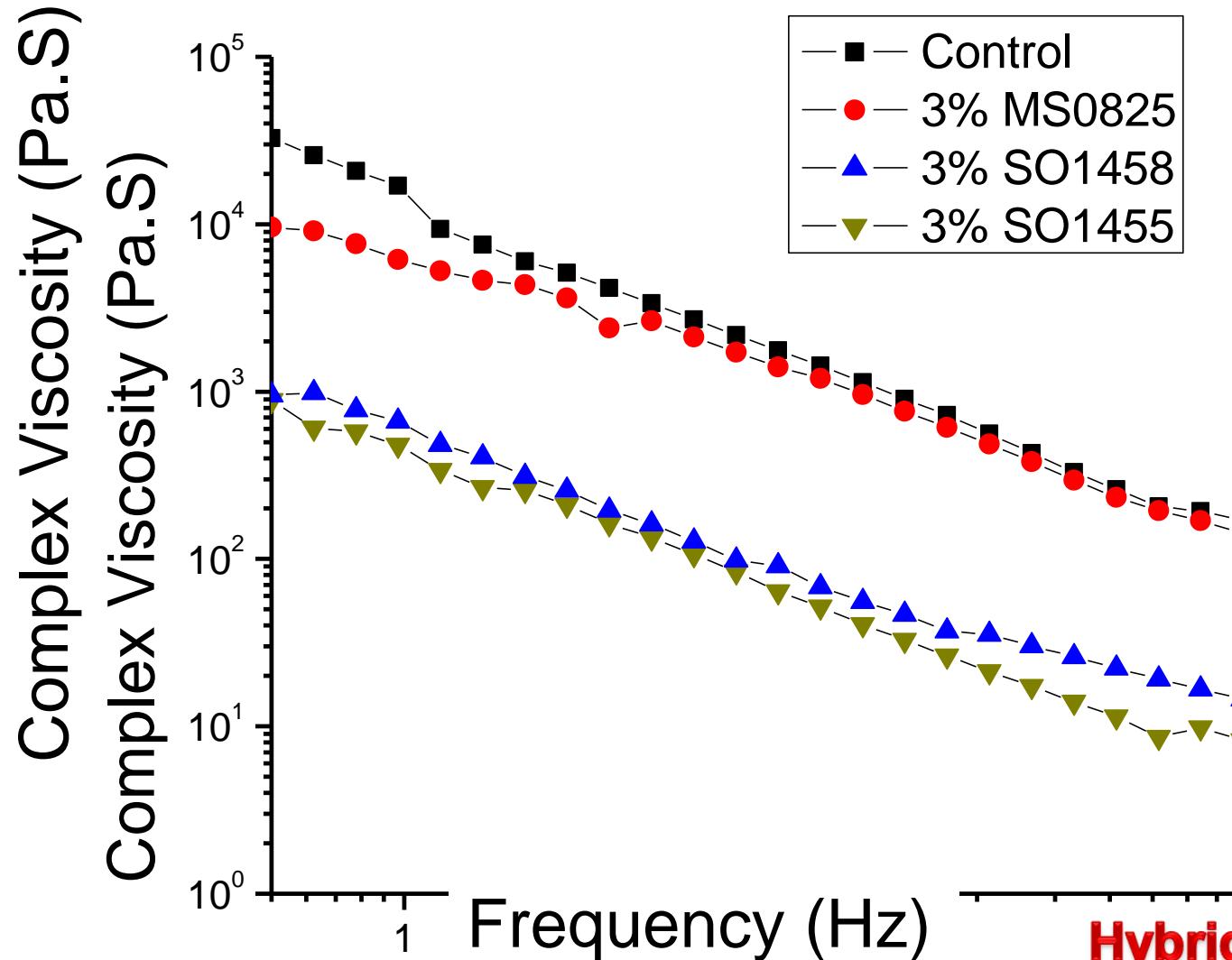
PP with 1wt%
TiO₂



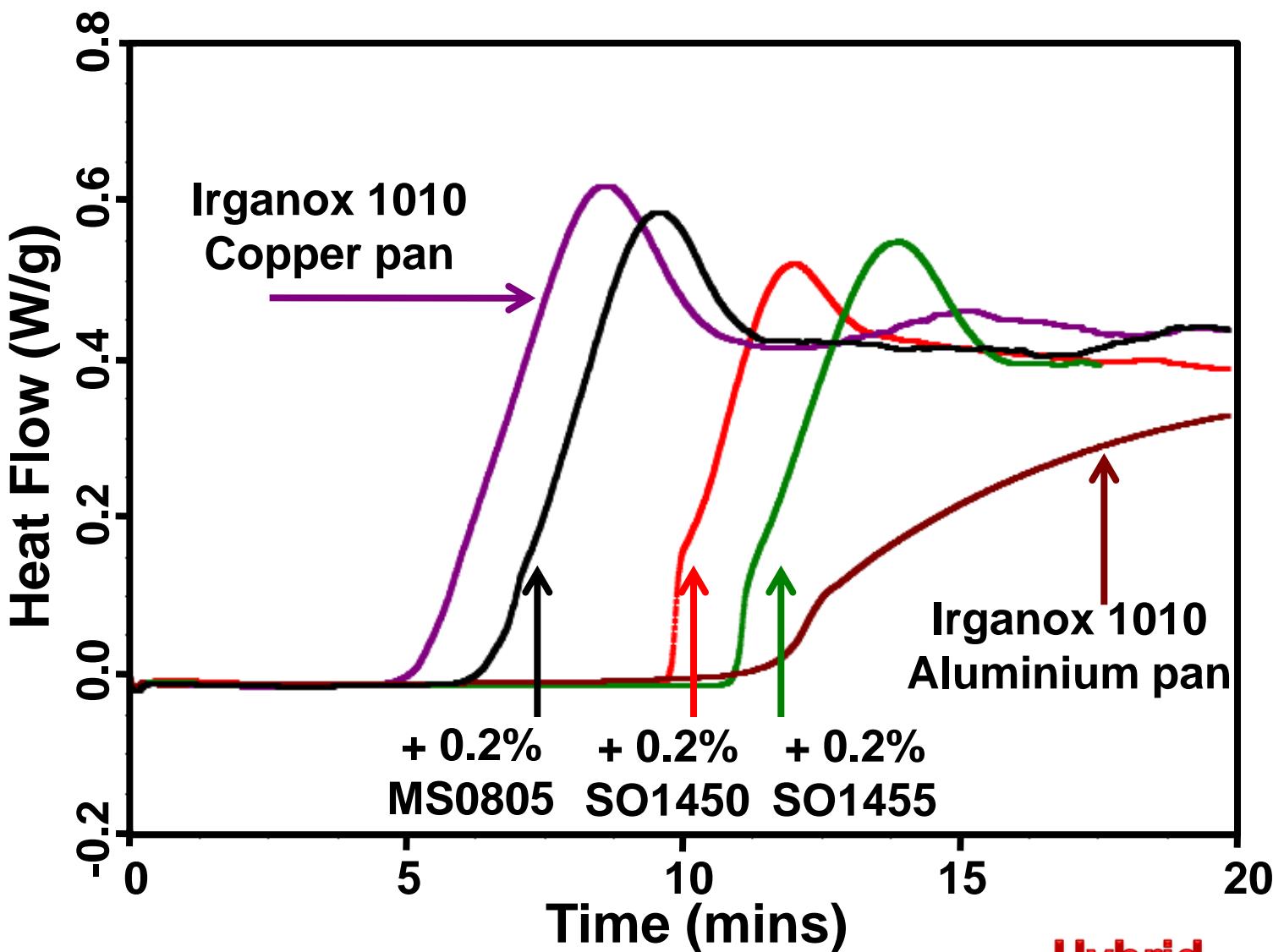
PP with 1wt% TiO₂
+ 5 wt% POSS

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POSS® Dispersants for Boron Nitride



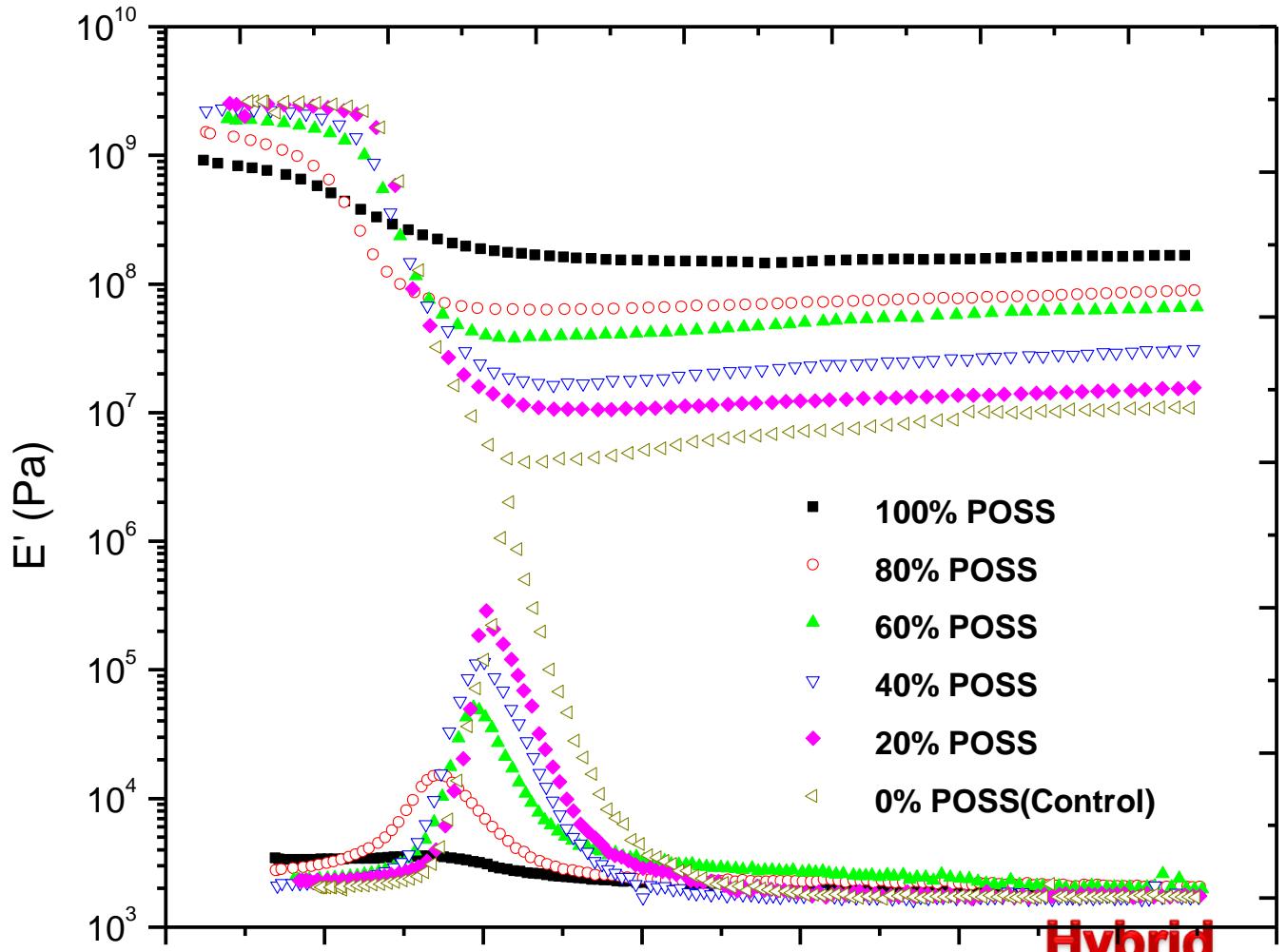
POSS® Passivating Agent for Copper



In hydrocarbon oil (squalane) 190°C, oxygen atmosphere

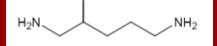
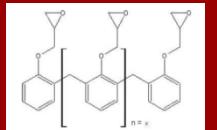
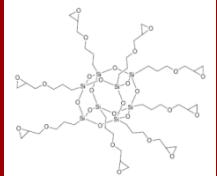
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POSS® Epoxy Retains Modulus

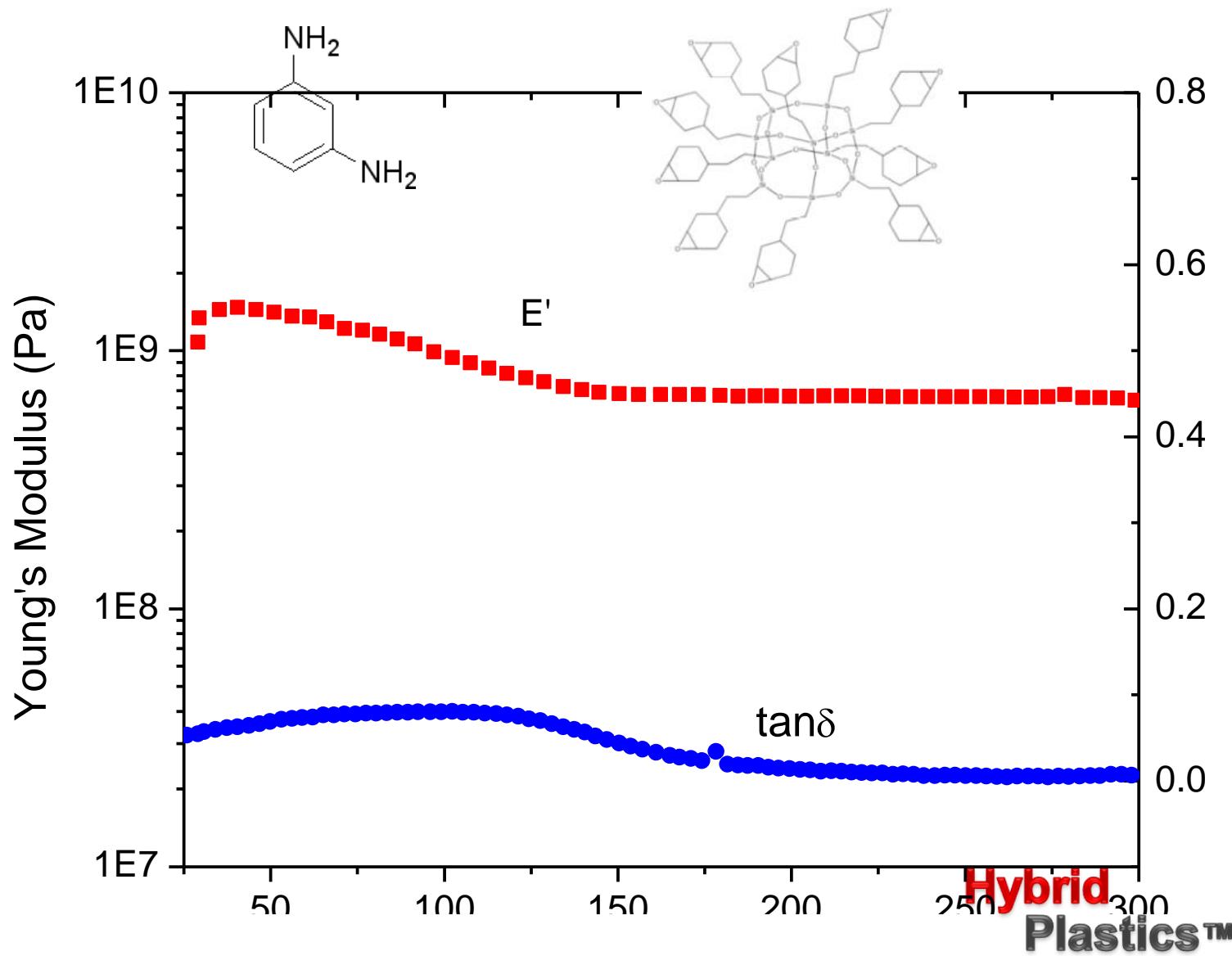


Ambient cure for 3 days; DMA 2°C/min, 1Hz

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POSS® Ultra-High Temperature Epoxy



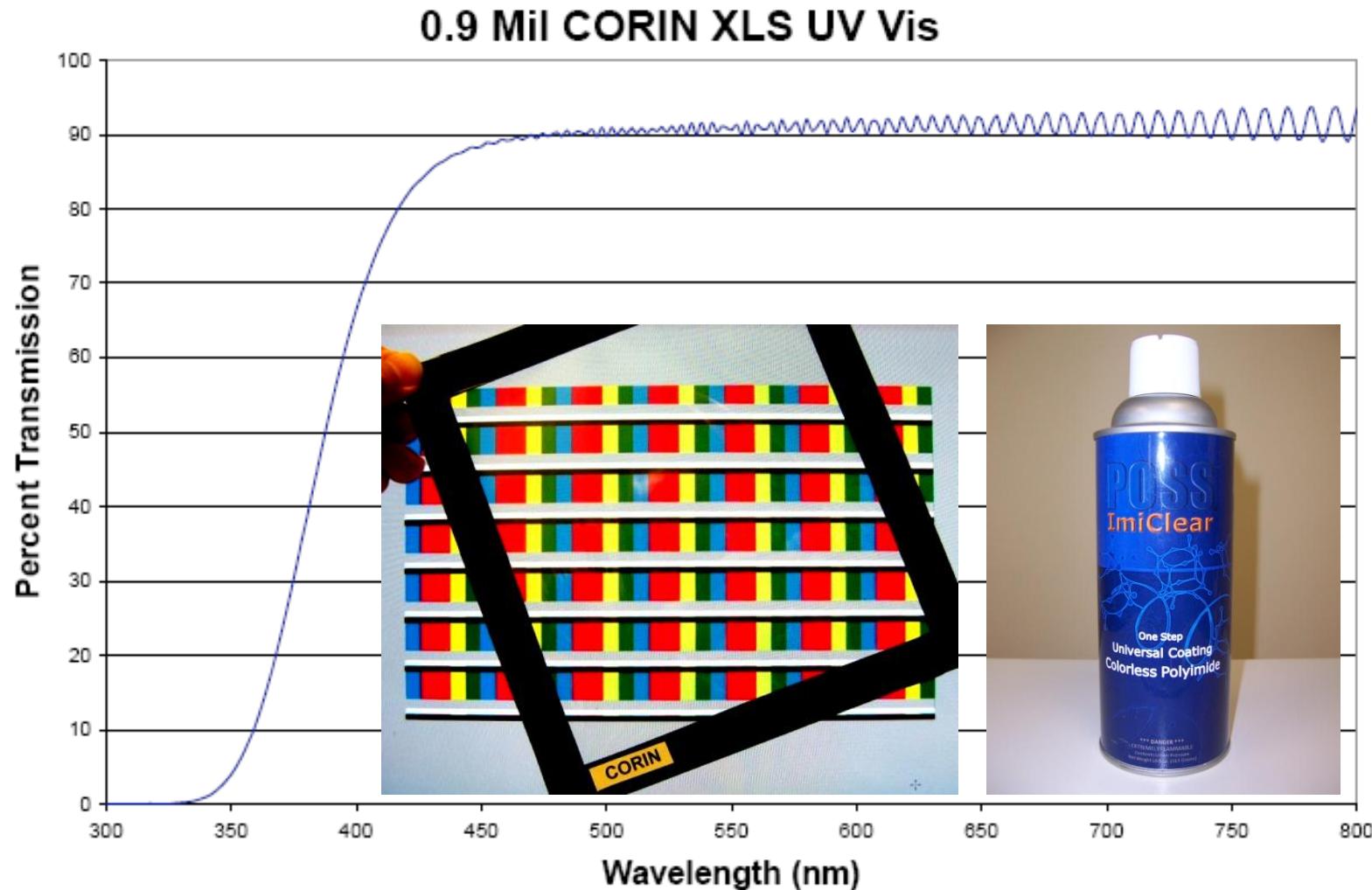
Reduced Solvent Swelling

Material Type	Weight increase (%)
Silicone + 0% POSS	25
Silicone + 20% POSS	19
Silicone + 40% POSS	14
Silicone + 60% POSS	10

- High cross-link density
- The cage cannot swell

1 week in acetone

POSS® Colorless Polyimide Spray



Tg 250°C; tensile strength 74MPa; elongation 8%; CTE 68 um/m/°C

With ManTech Corp.

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Safety of POSS®

Several of the larger production volume POSS® types are TSCA listed

Octaisobutyl POSS® MS0825

US Category IV Oral LD50 > 5000 mg/kg

Octamethyl POSS® MS0830

EU Oral LD50 > 2000 mg/kg

Dodecaphenyl POSS® MS0802

EU Oral LD50 > 2000 mg/kg

Does **not** require the risk phrase R22
"Harmful if Swallowed."

Tested on rats by independent accredited laboratory

Tooth Restoration Products



**Nano-Bond® Nano-Particulate
Reinforced Adhesive System**



Artiste™ Nano-Hybrid Flowable Composite



TempSpan GLAZE Eliminates Polishing Step

NIH sponsored products

 **PENTRON®**
CORPORATION

**Hybrid
Plastics™**

POSS® in Food Packaging



- POSS® incorporation provides longer shelf life
- Film blowers like it because it is cheaper to use
- Improves color printing

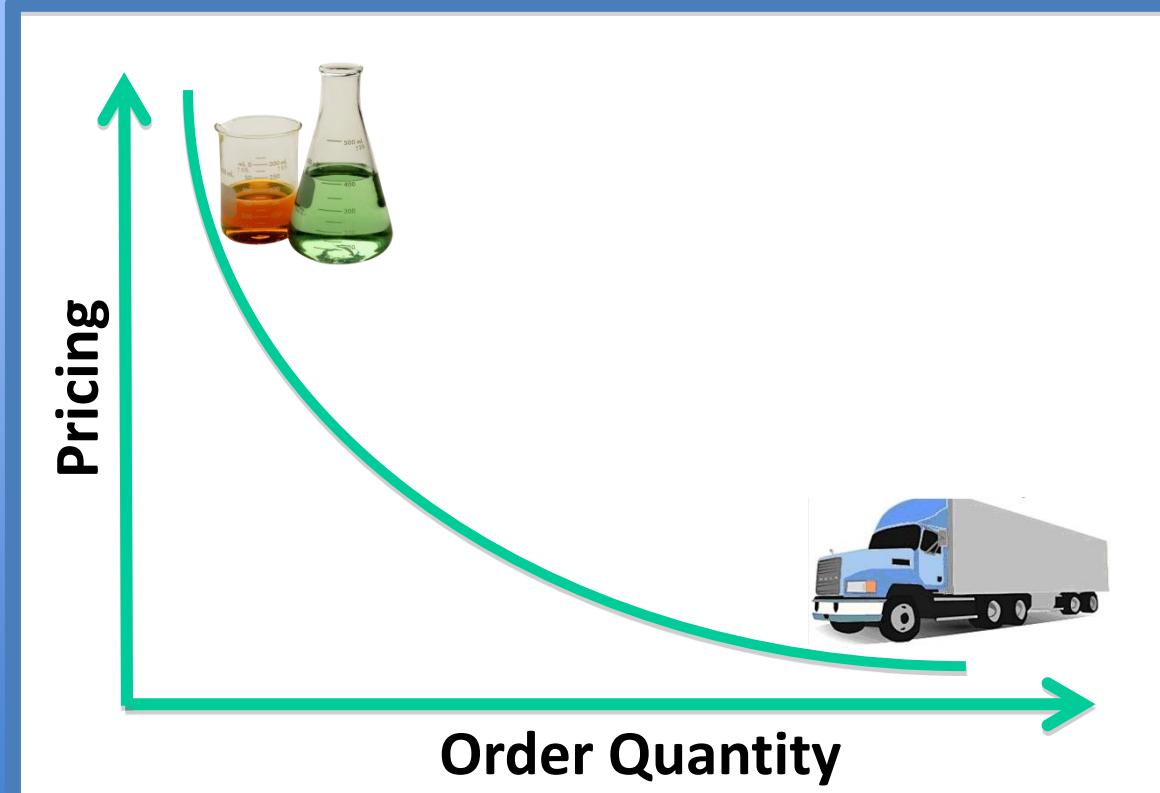


**Hybrid
Plastics™**

Hybrid Plastics™ Inc.



POSS® Pricing



Summary

- POSS® additives available neat or in masterbatch concentrate
- The hybrid structure provides unique property combinations
- Hybrid Plastics works closely with customers to develop new products
- Custom synthesis of new actives available



Thank you!